ZHDANOV, M.M.; KOSTRYUKOV, G.V.; ASFANDIYAROV, Kh.A.; MAKSUTOV, R.A.; KONDAKOV, A.N.; TURUSOV, V.M.; SILIN, V.A.; PILYUTSKIY, O.V.; SHELDYBAYEV, B.F.; PETROV, A.A.; SMIRNOV, Yu.S.; KOLESNIKOV, A.Ye.; DROZDOV, I.P.; IVANTSOV, O.M.; TSYGANOV, B.Ya.; KORNONOGOV, A.P.; VDOVIN, K.I.; ALEKSEYEV, L.A.; GAYDUKOV, D.T.; LIP[redacted]SKIY, A.Ya.; DANYUSHEVSKIY, V.S.; VEDISHCHEV, I.A.; ALEKSEYEV, L.G.; KRASYUK, A.D.; IVANOV, G.A.

Author's communications. Neft. i gaz. prom. no.2:67-68 Ap-Je '64. (MIRA 17:9)

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001550610010-2"

05197
SOV/142-2-3-5/27

9(2,3)

AUTHOR: Silin, V.D.

TITLE: The Multivibrator Turnover Potential

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiotekhnika, 1959, Vol 2, Nr 3, pp 299-306 (USSR)

ABSTRACT: In this paper the author presents the analytical dependences for the turnover potential of a self-excited multivibrator, which facilitate sufficiently accurate calculations of the duration of the generated pulses. The results of the analyses have been confirmed experimentally. Although, the turnover potential is one of the basic parameters of any multivibrator circuit, the available literature does not contain satisfactory analytical expressions or descriptions of experimental methods for determining its magnitude. Most authors identify the turnover potential with the so-called tube-blocking potential, (Ref.1,2,3,4,5). This results in the widely used expression for the turnover potential $E_g = \frac{E_a}{\mu}$ where E_a is the voltage of the anode feed source; μ -tube amplification factor. The inaccuracy of the aforementioned approach

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The Multivibrator Turnover Potential

was also noted in ref.5 by A.M. Bonch-Bruyevich. The aforementioned deficiency of the generally accepted representation of the turnover potential does not lead to any serious errors in investigations as long as it does not touch the problem of operational stability of multivibrator circuits. In the latter case, such an analysis will meet essential difficulties. In this paper, the author presents some results of his theoretical and experimental investigations of the turnover potential of some typical circuits of self-excited multivibrators composed of triodes, as shown in fig.1. He discusses the anode-grid characteristics approximation of triodes in the area of small currents. He derives an analytical expression for the turnover potential. The investigation of experimental circuits, as shown in the block diagram, fig.5, confirmed the correctness of the analytic conclusions. The author conducted a number of multi-vibrator circuits measurements with tubes 6N8S, 6N1P and 6N3P. The author compared the experimental data with theoretical data obtained according to the formula

$$E'_{g0} = E_{g0} - U_{oc} = \frac{E_a}{\mu} + \frac{1}{q} \ln q\, i_0 + \frac{1}{q} \ln S_{\partial 2} R_{a2} R_{a1}$$ and

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with the first mentioned formula. The results of this paper confirm indirectly the suitability of using the exponential approximation of the initial section of the anode-gred characteristics of triodes. The publication of this paper was recommended by the Kafedra Moskovskogo aviatsionnogo instituta imeni Sergo Ordzhonikidze (Moscow Aviation Institute imeni Sergo Ordzhonikidze). There are 2 circuit diagrams, 2 graphs, 1 block diagram and 7 Soviet references.

SUBMITTED: July 3, 1958 (November 19, 1957)

Card 3/3

05374
SOV/106-59-8-6/12

AUTHOR: Silin, V.B.

TITLE: The Effect of Variation in Valve Parameters on the Pulse Duration in Multivibrator Circuits

PERIODICAL: Elektrosvyaz', 1959, Nr 8, pp 43 - 51 (USSR)

ABSTRACT: The object of the article is to determine the variation in the value of the pulse duration T or in the value of the oscillation period of multivibrators when their valves are replaced. The article is restricted to multivibrator circuits which employ triodes. The relative pulse duration variation is given by:

$$\frac{\Delta T}{T} \approx - \frac{1}{\ln \dfrac{E_o + U_{g0}}{E_{g0} + U_{g0}}} \; \frac{E_{g0}}{E_{g0} + U_{g0}} \; \frac{\Delta E_{g0}}{E_{g0}} \qquad (3)$$

where E_o is the ampltidue of the pulse voltage at the

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anode of the conducting valve; E_{g0} is the trigger potential of the closed valve; U_{g0} is the potential of the point of connection of the grid-leak resistance to the grid of the multivibrator valve. E_{g0} is considered a valve parameter, since it is almost independent of the other circuit parameters. But, since E_o depends on the anode loads, Eq (3) cannot be used directly to find the effect of valve replacement.

Assuming that the anode characteristic is linear and has the form shown in Figure 2, the relative change in $E_o(\Delta E_o/E_o)$ for a relative change $(\Delta R_i/R_i)$ in the internal resistance of the valve is given by:

$$\frac{\Delta E_o}{E_o} \approx - \frac{R_i}{R_a + R_i} \frac{\Delta R_i}{R_i} \qquad (5)$$

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-placement depends on the
-ters of the triodes: in the anode

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current i_a, determined at some particular anode voltage, and in the trigger potential E_{g0}. The form of Eqs (3) and (8) are such that a change can be made from the unknown relative variations to the variation coefficients of i_a and E_{g0} (Ref 2). The latter are dimensionless characteristics of the variation in the random value of T due to changes in i_a, $-(V_T(i_a))$ and due to changes in E_{g0}, $-(V_T(E_{g0}))$ and equal the ratios of its mean square standard deviation σ_T to its mean value $\bar{T}$, when each parameter varies. The variation coefficients can be combined to account for simultaneous, independent variation in i_a and E_{g0}:

$$V_T(i_a, E_{g0}) = \sqrt{V_T^2(i_a) + V_T^2(E_{g0})} \quad (12).$$

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This assumes that the triodes are not halves of a double triode. In the case when there is correlation ρ between the variations in E_{g0} and i_a, then:

$$V_T(i_a, E_{g0}) = \sqrt{V_T^2(i_a) + V_T^2(E_{g0}) + 2\rho V_T(i_a)V_T(E_{g0})} \quad (13) .$$

The article then gives the results of experimental investigation in which the circuits shown in Figures 3 and 4 were used.

It is concluded:

1) correlation between i_a and E_{g0} increases the stability of the circuit against valve replacement, especially for free-running circuits.

2) With proper selection of the circuit parameters, the stability improves 3-4 times when $U_{g0} = E_a$ (the HT supply voltage), compared to the stability when $U_{g0} = 0$.

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The Effect of Variation in Valve Parameters on the Pulse Duration in Multivibrator Circuits

3) With proper choice of valves having the highest possible correlation between their parameters and making $U_{g0} = E_a$, the maximum deviation in the oscillation period when the valves are replaced will not exceed 1.5 - 2%.

There are 11 figures, 2 tables and 3 Soviet references.

SUBMITTED: April 26, 1959

Card 6/6

SILIN, V. L., Cand Tech Sci -- (diss) "Stability of the performance of schemes of multivibrators." Moscow, 1960. 16 pp; (Ministry of Higher and Secondary Specialist Education RSFSR, Moscow Order of Lenin Aviation Inst im S. Ordzhonikidze); 160 copies; price not given; (KL, 22-60, 139)

SILIN, V. B.

PHASE I BOOK EXPLOITATION SOV/5197

Moscow. Aviatsionnyy institut imeni Sergo Ordzhonikidze

Voprosy impul'snoy tekhniki i elektronnykh vychislitel'nykh ustroystv; sbornik statey (Problems in Pulse Technique and Electronic Computers; Collection of Articles) Moscow, Oborongiz, 1960. 102 p. 9,150 copies printed. (Series: Its: Trudy, vyp. 126).

Sponsoring Agencies: Ministerstvo vysshego i srednego spetsial'nogo obrazovaniya RSFSR, and Moskovskiy ordena Lenina aviatsionnyy institut imeni Sergo Ordzhonikidze.

Ed. (Title page): V. T. Frolkin, Candidate of Technical Sciences, Docent; Ed. (Inside book): Ya. N. Luginskiy, Engineer; Ed. of Publishing House: E. A. Shekhtman; Tech. Ed.: V. I. Oreshkina; Managing Ed.: A. S. Zaymovskaya, Engineer.

PURPOSE: This collection of articles is intended for scientific and technical personnel, and for students in advanced courses in

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schools of higher education.

COVERAGE: The articles describe the results of investigations carried out by the MAI (Moscow Aviation Institute) on the following subjects: stability of the operation of multivibrator circuits; comparative analysis of relaxation oscillators with a capacitive plate-grid coupling (phantastron oscillators); a device for pulse-code modulation of voltage into a binary digital code; analysis of the stability of the moment of synchronization of a driven blocking oscillator, and a number of other problems of pulse technique. No personalities are mentioned. References accompany all the articles.

TABLE OF CONTENTS:

SILIN, V.B., inzh.

Dependence of the pulse durations of a multivibrator on fluctuations in the plate voltage supply. Trudy MAI no.126:5-44 '60. (MIRA 14:1)

(Oscillators, Electric)
(Pulse techniques (Electronics))

SILIN, V. I.

ALEKPEROV, S.-M.A.; MASYUTA, V.F.; SILIN, V.I.; CHERNYAYEV, G.I.; GOLOVANOV, V.V., redaktor; MEDNIKOVA, A.N., tekhnicheskiy redaktor

[Gymnastics] Sportivnaia gimnastika. Moskva, Voen.izd-vo M-va obor. SSSR, 1957. 60 p. (MIRA 10:8)
(Gymnastics)

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001550610010-2"

[illegible]

[illegible] ... USSR. Moskva, [illegible], 19[illegible]

[illegible]

SILIN, V. N.

SILIN, V. N. -- "The Most Important Problems in the Production of Hay in the USSR." All-Union Sci Res Inst of Fodders imeni V. R. Vil'yams, Moscow, 1955. (Dissertations for the Degree of Candidate of Agricultural Sciences)

SO: Knizhnaya Letopis: No. 39, 24 Sept 55

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001550610010-2"

DEMEZER, A.A.; DZYUBA, M.L.; BLINOV, L.F. kandidat sel'skokhozyaystvennykh nauk; BOLDYREV, N.I., kandidat pedagogicheskikh nauk; GAY-GULINA, Z.S, GRUDEV, D.I., kandidat sel'skokhozyaystvennykh nauk; DUBROV, Ya.G., professor; KOVALENKO, V.D., ;KRYSINA, O.I.; KURKO, V.I.; LEVI M.F., kandidat sel'skokhozyaystvennykh nauk; MORDKOVICH, M.S.; POPOV, I.P. kandidat biologicheskikh nauk;SAGALOVICH, Ye.N., agronom; SILIN, V.N., zootekhnik; STRUYANSKIY, I.L., vrach; SUSHKOVA-LYAKHOVICH, M.L., kandidat meditsinskikh nauk; SHAPOVALOV, Ya.Ya., kandidat sel'skokhozyaystvennykh nau; SHENDERETSKIY, E.I., kandidat sel'skokhozyaystvennykh nauk; YAVNEL', A.Yu., kandidat meditsinskikh nauk; RODINA, P.I., redaktor; YUROVITSKIY, Ye.I., redaktor;PEVZNER, V.I., tekhnicheskiy redaktor.

[Home economics] Domovodstvo. Moskva, Gos.izd-vo sel'khoz.lit-ry. 1956. 479 p. (MIRA 10:5)

(Home economics)

USSR/Farm Animals - General Problems. Q-1

Abs Jour : Ref Zhur - Biol., No 7, 1958, 30898

Author : Silin V.N.
Inst : -
Title : The Most Important Problems in the Production and Utilization of Hay.
(Vazhneyshiye voporsy proizvodstva i ispol'zovaniya sena).

Orig Pub : Vestn. s.-kh. nauki, 1956, No 3, 73-83.

Abstract : The article gives a general description of hay resources of the forest-meadow, steppe, and desert-steppe zones of the USSR. The conditions required for the increase of the productivity of grasses and the procurement of high quality hay in large quantities, the role of hay in the feed rations of different farm animals, and the effectiveness of hay meal as well as that of hay infusion, are pointed out.

Card 1/1

SILIN, V. N., Cand Agr Sci -- (diss) "Most important conditions of the preparation of hay, and its utilization." Leningrad-Pushkin, 1960. 21 pp; (Ministry of Agriculture RSFSR, Leningrad Agricultural Inst); 180 copies; price not given; (KL, 18-60, 154)

SILIN, V.N.

Zootechny as a creative occupation. Zhivotnovodstvo 24 no.6:13-18 Je '62. (MIRA 17:3)

SILIN, V. M.

"Investigation Of Glue-Steel Junctions in Application to Sectional Wooden Bridges." Sub 26 Feb 51, Military Red Banner Engineering Academy imeni V. V. Kuybyshev

Dissertations presented for science and engineering degrees in Moscow during 1951.

SO: Sum. No. 480, 9 May 55

KOBIKOV, G., kand.tekhn.nauk; SILIN, V., kand.tekhn.nauk; SHEVCHENKO, G., kand.tekhn.nauk

Glued-wood structures used in bridge consturction. Avt.dor. 20 no.12:19-21 D '57. (MIRA 12:4)
(Bridges, Wooden)

KOBIKOV, G., dots., kand. tekhn. nauk, podpolkovnik; SILIN, V., dots. kand. tekhn. nauk, inzhener-podpolkovnik; SHEVCHENKO, G., kand. tekhn. nauk, podpolkovnik.

The use of glued units in military engineering. Voen.-inzh. zhur. 102 no.3:38-41 Mr '58. (MIRA 11:4)
(Plywood) (Military engineering)

IVANOVA, Yelena Konstantinovna, kand tekhn. nauk; SILIN, V.N., kand. tekhn. nauk, nauchnyy red.; VILKOV, G.N., red. izd-va; RUDAKOVA, N.I., tekhn. red.

[Glued wooden structures] Kleenye derevіannye konstruktsii; opyt stroitel'stva za rubezhom. Moskva, Gos. izd-vo lit-ry po stroit. i arkhit. i stroit. materialam, 1961. 82 p. (MIRA 14:10)
(Building, Wooden)

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R001550610010-2"

KARLSEN, G.G., doktor tekhn.nauk, prof.; BOL'SHAKOV, V.V., doktor tekhn.nauk, prof.; KAGAN, M.Ye., doktor tekhn.nauk, prof.; SVENTSITSKIY, G.V., kand.tekhn.nauk, dotsent; ALEKSANDROVSKIY, K.V., dotsent; BOCHKAREV, I.V., kand.tekhn.nauk, dotsent [deceased]; FOLOMIN, A.I., doktor tekhn.nauk; Prinimali uchastiye: KOLOMNIN, G.P., inzh.; SILIN, V.N., dotsent, kand.tekhn.nauk; PISCHIKOV, V.G., kand.tekhn.nauk, dotsent, nauchnyy red.; IVANKOV, P.T., dotsent, red.; BORODINA, I.S., red. izd-va; RUDAKOVA, N.I., tekhn.red.

[Wooden structures] Dereviannye konstruktsii. Izd.3., perer. i dop. Moskva, Gos.izd-vo lit-ry po stroit., arkhit. i stroit. materialam, 1961. 642 p. (MIRA 15:2)

1. Chlen-korrespondent Akademii stroitel'stva i arkhitektury SSSR (for Karlsen).

(Building, Wooden)

[illegible], [illegible] [illegible]fo[illegible]vna, [illegible] tekhn. nauk; [illegible], Nikolay [illegible]yevich, inzh.; [illegible], V.N., red.

[Glued bridge spans] Kleenye proletnye stroeniia mostov. Moskva, Transport, 196[illegible]. 8[illegible] p. (MIRA 17:6)

1951-1960

S.A

Field Theory

Sect. A

530.145

772. On the self-energy of the electron. V. P. Silin. Zh. Eksper. Teor. Fiz., 21, 462-5 (No. 3, 1951) In Russian.

Inclusion of exchange effects of the electron with the meson field leads to results whose influence on the self-energy in the high energy region proves more important than that of the gravitation field. A correction of diverging self-energy expressions thus cannot lie in consideration of non-linear effects connected with gravitation.

J. JACOBS

1ST AND 2ND ORDERS

PROCESSES AND PROPERTIES INDEX

3RD AND 4TH ORDERS

N

4

4776

ON THE SELF-ENERGY OF THE ELECTRON. V. P. Silin. Zhur. Eksptl'. i Teoret. Fiz. 21, 468-73(1951) Mar. (In Russian)

It is shown that gravitational effects may prove unimportant in the general problem of the self-energy of the electron. A calculation of the interaction between an electron and a meson field may show that in the domain of high energies this interaction influences the expression for the electron's self-energy in a much higher degree than does the gravitational field.

ASM-SLA METALLURGICAL LITERATURE CLASSIFICATION

SILIN, V. P.

USSR/Electricity - Superconductivity Dec 51

"Superconducting Cylinder and Sphere in a Magentic Field," V. P. Silin, Inst Phys imeni P. N. Lebedev, Acad Sci USSR

"Zhur Eksper i Teoret Fiz" Vol XXI, No 12, pp 1330-1336

Discusses problem of behavior of superconducting cylinder and sphere in homogenous magnetic field on basis of new pherqmenological theory. Obtains expression for magnetic susceptibility, as function of field temp. Investigates breakdown of superconducting state of superconductors of small size. Submitted 9 Mar 51.

198T12

SILIN, V. P.

USSR/Nuclear Physics - Mesons Feb 52

"Theory of Capture of π-particles in Deuteron,"
I. Ya. Pomeranchuk

"Zhur Eksper i Teoret Fiz" Vol XXII No 2, pp 129-135

From American expts (cf Phys Rev, 81,565, 1951), the
author establishes the probability ratios of the
processes: $p+\pi^- \rightarrow n+\pi^0$ and $d+\pi^- \rightarrow n + n + \pi^0$ without
application of the meson theory. Similarly he finds
ratios of radiative capture: $p+\pi^- \rightarrow n+\gamma$, $d+\pi^- \rightarrow n + n+\gamma$
Shows that exact measurement of ratio of amts π^0 in p
and in d may enable one to establish number and spin
of π and π^0. Indicates the general connection among

207T96

USSR/Nuclear Physics - Mesons (Contd) Feb 52

the processes with participation of slow mesons in
hydrogen and deuteron. Indebted to B. Ioffe, A.
Rudik and I. Shmushkevich. Received 3 May 51.

207T96

Physics

7i 8.2.

295
SPIN-ORBITAL INTERACTION OF NUCLEONS. V. P Silin. Zhur. Eksptl'. i Teoret. Fiz. 22, 136-9(1952) Feb. (In Russian)

Operators for the interaction energy of two nucleons for the case of neutral scalar and neutral pseudoscalar theory with derivativeless couplings are found in an approximation that is quadratic in the coupling constant. (G Y.)

Physics Inst im Lebedev, AS USSR

SPECTROSCOPY

8233 AEC-tr-2724

CONCERNING THE SPECTRA OF SYSTEMS OF INTERACTING PARTICLES, Yu. L. Klimontovich and V. P. Silin. Translated from Zhur. Exptl. i Teoret. Fiz. 23, 151-80(1952). 13p.

An equation is derived for the quantum distribution function, which is a generalization of a well known classical equation. With the aid of this equation, the excitation (vibration) spectra of macroscopic systems of interacting particles is investigated. The quantum dispersion equation is found, which connects the frequency and the logarithmic decrement of damping with the vibration wave vector for such systems. For negligible damping the vibration spectra of degenerate Bose and Fermi systems with central forces is obtained. The case of magnetic interaction between particles is analyzed. (auth)

SILIN, V.P.

5,

USSR •

537.591

10288. **On the theory of the excitation spectra of a system of multi-particles.** V. P. SILIN. *Zh. eksper. teor. Fiz.*, 23, No. 6 (12), 641-5 (1952) *in Russian.*

The spectra of systems of multi-particles with central interaction are considered at high temperatures (Boltzmann distribution), as well as at low temperatures (Fermi distribution). In the region of long wavelengths the excitations correspond to those obtained in the investigation of the classical kinetic equation with self-consistent interaction. In the region of short wavelengths the quantum character of the excitations becomes essential. Transverse vibrations were considered in a system of electrons placed in a medium with a dielectric constant.

E. RABKIN

SILIN, V.P.

5

USSR.

537.561

10289. On the excitation spectrum of a system of electrons and ions. V. P. SILIN. *Zh. eksper. teor. Fiz.*, 23, *No.* 6 (12), ~~[illegible] (1952)~~ *In Russian.*

In the short-wave region the electrons and ions are excited independently of each other. Long-wave excitation can be represented by two branches of vibrations: one has a finite maximum frequency and the other corresponds to sonic vibrations. At low temperatures the sonic vibrations are weakly attenuated, but at high temperatures, by contrast, the attenuation is comparatively strong, and they are propagated only over distances comparable to the wavelength.

E. RABKIN

Rew [illegible]

SiLiN, V.P.

USSR .

The theory of excitation spectra of macroscopic systems. 1,2
Yu. L. Klimontovich and V. P. Silin (M. V. Lomonosov 1
State Univ., Moscow). Doklady Akad. Nauk S.S.S.R.
82, 361-4(1952).—In order to obtain a possibly complete
analogy between the quantum-theoretical and the classical
treatment, the quantum distribution function $f(p,q,t)$ is
expressed in terms of the d. matrix, and the momentum
deriv. $\partial f/\partial p$ in the Boltzmann equation for $f(p,q,t)$ is re-
placed by an integral whose integrand contains a finite
difference. An approximation procedure for the treatment
of collision problems is then given. This leads to an expres-
sion for the spatial-distribution function which is represented
as a fraction. The zeros of the denominator of this expres-
sion determine the spectrum of the system considered in-
dependently of its initial state. The peculiarities of the
initial state appear in the numerator only. Special solu-
tions are given for a fully degenerate electron plasma and for
a fully degenerate system of Bose particles. E. Gora

[illegible]

Silin, V. P. -- "[illegible] Spectrum of [illegible] by Means of a [illegible]." [illegible] Phys-[illegible] Sci, [illegible], [illegible] 1953.
([illegible], No 1, Jan 1[illegible])

[illegible]

4

USSR •

530.145

9941. **On a relativistic theory of the interaction of nucleons.** I. E. Tamm, V. P. Silin and V. Ya. Fainberko. *Zh. eksper teor. Fiz.*, 24, No. 1, 3-13 (1953) *In Russian.*

It is shown that a relativistic treatment of two nucleons interacting through a pseudoscalar meson field with pseudovector coupling does not alter a previous conclusion [I. Tamm, *Journal of Physics, USSR*, 9, 449 (1945)] about the instability of the system because of the pole at $r = 0$. The potentia obtained from second-order perturbation theory i. considered. In another section, the work of Lev [Abstr. 80 (1952)] concerning pseudoscalar mesons with pseudoscalar coupling is considered. It is shown that his conclusions of no binding and infinite energy for the two-nucleon system, are incorrect.

G. L. Brov—

Rmf

USSR.

50. On a theory of interaction of nucleons and mesons. V. P. Silin. *Zh. éksper. teor. Fiz.*, 24, No. 4, 389–96 ([redacted]n.

The method of Tamm is used to describe the system of nucleon + one pseudoscalar π-meson with pseudoscalar coupling. Nucleon recoil is neglected and angle variables are separated out. In this approximate treatment the interaction vanishes except in P states. It is shown that the high momentum components of the wave-function of this system do not cut off sufficiently rapidly to give a finite energy. G. E. BROWN

AmL

SILIN, V. P.

ON THE SCATTERING OF π-MESONS BY NUCLEONS. V. P. Silin. Zhur. Eksptl'. i Teoret. Fiz. 25, No. 2, 255-6(195?). (In Russian)

The experimental data for the scattering of mesons in the $S_{1/2}$ state determine only two parameters (scattering length a and range of force r_0) in a phenomenological theory. With a particular choice of $a = 0.3\hbar/\mu c$ and $r_0 = 1.05\hbar/\mu c$, agreement with experiment is obtained. (Science Abstracts)

SILIN, V.P.

Nuc Sci 6/2

Photographic Abs
Apr 4 1953
Industrial & Scientific
Application of Photography

SCATTERING OF π-MESONS BY NUCLEONS. V. P. Silin and V. Ya. Fainberg. Uspekhi Fiz. Nauk 50, 325-64(1953) July. (In Russian)

The accumulated results of experimental work on scattering of π-mesons by H_2 and D_2 are discussed. Correlation of the scattering results in a theory of isotopic spin. The general theory of π-meson scattering by nucleons and the experimental data are interpreted. The theory of weak and strong bonds in the interaction of π-mesons and nucleons is presented. 83 references. (U.S.R.)

RML
4-19-54

SILIN, V. P.

USSR/Nuclear Physics - Wave equations

FD-747

Card 1/1 : Pub 146-17/22

Author : Ginzburg, V. L., and Silin, V. P.

Title : Some remarks on relativistic wave equations with mass spectrum

Periodical : Zhur. eksp. i teor. fiz., 27, 116-118, Jul 1954

Abstract : Letter to the editor. Analyze equations from works by H. Yukawa (Phys. Rev. 91 [1953]). A. Pais (physica, 19 [1953]) and J. Rayski (Nuovo Cimento, 10, [1953]) and the reasons for the divergences in computations. 11 references, including the 3 mentioned foreign.

Institution : Physical Institute imeni Lebedev, Acad. Sci. USSR

Submitted : April 19, 1954

SILIN, V. P.

USSR

755. On the spectrum of excited systems of man particles. V. P. SILIN. *Zh. eksper. teor. Fiz.*, 27, No. 3(9) 2[redacted]ussian.

The influence of the correlation of particles arising from their identity (from symmetrization or anti-symmetrization) on the statistical distribution function for many particles is investigated in first order in. effects. The spectrum differs only slightly from that given by the self-consistent field approach. It is shown that this latter approach is inapplicable in an electron-ion plasma if the interaction energy between particles is comparable to their kinetic energy. U. F. BROWN

BBAmf

Silin, V.P.

USSR. Silin, V. P. On a modified Tamm method. Ž. Eksper. Teoret. Fiz. 27, 754–756 (1954). (Russian)

Using the method of Tamm and Dancoff [i.e., Tamm, Acad. Sci. USSR. J. Phys. 9, 449–460 (1945)] the author sets up the scattering equation for one meson and one proton in the lowest approximation. It is shown how the proton and meson self-energies may be consistently renormalized, following the ideas of M. Cini [Nuovo Cimento (9) 10, 614–629 (1953); MR 15, 768]. *F. J. Dyson* (Princeton, N. J.).

SILIN, V.P.

Quantum kinetic equations in the study of the spectrum of a many--particle system. Trudy Fiz.inst. 6:199-268 '55. (MLRA 9:5)
(Particles, Elementrary--Spectra) (Quantum theory)

USSR/Nuclear Physics - Excitation spectrum of many-particle system FD-2356

Card 1/2 Pub. 146 - 23/34

Author : Silin, V. P.

Title : Concerning the article "Spectrum of excitations of a system of many particles"

Periodical : Zhur. eksp. i teor. fiz. 28, 749-750, Jun 1955

Abstract : By considering the correlation of particles which is due to their identity one can distinguish the correlation of particles which are in identical spin states and the correlation of particles which are in different spin states. In his earlier article (Ibid. 27, 1954) the author utilized an approximation of the binary function of distribution, which approximation corresponds to taking into account the correlation due to the identity of particles which are in identical spin states. In the present article the author considers the case of the electron, as against the case of Bose particles without spin. He finds that the spectrum of spin excitations of a degenerate Bose gas of particles with unit spin possesses the form of a spectrum of noninteracting particles, such a spectrum not satisfying the condition of superfluidity. He

therefore concludes that the superfluidity of helium is apparently due to not only Bose statistics, but also absence of spin in the atoms. He thanks Professor V. L. Ginzburg for judging the results. 1 ref.

Institution : Physical Institute im. P. N. Lebedev, Academy of Sciences USSR

Submitted : February 7, 1955

SILIN, V. P.

530.145

62 8502. **Method of truncated field equations and its application to the scattering of mesons by nucleons.** V. P. SILIN, I. E. TAMM AND V. YA. FAINBERG. ~~Zh. eksper. teor.~~ Fiz., 29, No. 1(7), 6–19 (1955) In Russian.

The so-called Tamm–Dancoff method is reformulated, beginning from covariant equations. From these, equations in three-dimensional momentum space are obtained. Boundary conditions are considered. Dyson's formulation in the physical vacuum [Abstr. 5854 (1953) 66, 97 (1954)] is applied and the relation to the old formulation in the bare vacuum discussed. The system of meson + nucleon is considered, taking into account coupling with amplitudes describing three or fewer virtual particles. Results obtained numerically by restriction to *S*- and *P*-waves are not included here, but will be reported separately. Renormalization is briefly considered. G. E. BROWN

2

Translation D 419421, p.107

SILIN, V. P.

537.311.31

2075. INFLUENCE OF INTER-ELECTRON COLLISIONS ON THE ELECTRICAL CONDUCTIVITY AND THE SKIN-EFFECT IN METALS. V.L.Ginsburg and V.P.Silin. Zh. eksper. teor. Fiz., Vol. 29, No. 1 (7), ~~64-75~~ (1955). In Russian.

Bentham and Kronig's statement that the electron viscosity in metals, resulting from electron interaction, influences the absorptivity of metals for infrared radiation was investigated. This would be important in metal-optics, electrical and thermal conductivity, skin effect etc. It was found that the above authors' method is incorrect, and their results wrong. Except for very high frequencies, the effects of electron interaction are negligible.

Electrical Research Association

SILIN, V. P.

300-1-RM2

530 145

2657. THE TAMM–DANCOFF METHOD. V.P. Silin and V.Ya. Fainberg.
Uspekhi fiz. Nauk, Vol. 56, No. 4, 569-635 (1955). In Russian.

Perturbation theory is not completely successful in its treatment of quantum meson dynamics. It is necessary to use methods of solution not associated with step-by-step analysis of the interaction constant. One such method, to which much effort has been devoted in the last three years is that of Tamm and Dancoff. The present article sets out the bases of the method and its application to various concrete problems of the quantum theory of mesons. The old T.–D. method is discussed in conventional and covariant forms and its application to the interaction of nucleons, interaction of π-mesons etc. The new T.–D. method is also applied to these problems.

C.R.S. Manders

(1)

RM2 AD

Silin, V.P.

3

Method of truncated field equations and its application to the scattering of mesons by nucleons. V. P. Silin, I. E. Tamm, and V. Ya. Fainberg. *Soviet Phys., JETP* 2, 3-13(1956)(Engl. translation).—See C.A. 49, 15512i.
B. M. R.

SILIN, V. P.

The theory of a collective description of the electron interaction in a solid body. V. P. Silin. *Fiz. Metall. i Metalloved.* 3, 193-9(1956).—Electron interactions represent an obstacle for a non-phenomenological theory of energy spectrum of solids, in the first line of metals. The present work, dealing with some questions related to the accounting for these interactions, uses kinetic matrix quantum equations for electron interactions and considers long waves (small *hk* values) with a small damping effect. Calcns. show that the interactions practically disappear when the excitation energy is small in comparison with the kinetic energy of particles. This is expected to happen at high densities of the degenerated electron gas, e.g. 10^{23} electrons per cc., as in metals Ag, Au, Cu. In many metals the electron interactions have the magnitude of corrections only.

B. Ryshkewitch

SILIN, V.P

USSR/Atomic and Molecular Physics - Low Temperature Physics, D-5

Abst Journal: Referat Zhur - Fizika, No 12, 1956, 34431

Author: Silin, V. P.

Institution: None

Title: (On) Certain Thermodynamic Inequalities

Original Periodical: Zh. eksper. i teoret. fiziki, 1956, 30, No 1, 197-199

Abstract: Thermodynamic inequalities are derived for substances, having magnetic and dielectric properties, and certain conclusions are made in the form of equilibrium magnetization curves of the magnetic material. The conditions of thermodynamic equilibrium of superconductors are analyzed.

1 of 1

SILIN, V.P

F-7

USSR / Magnetism, Magnetic Resonance.

Abs Jour : Ref Zhur - Fizika, No 3, 1957, 6901

Author : Silin, V.P.
Inst : Physics Institute, Academy of Sciences, USSR, Moscow.
Title : The Kinetics of Paramagnetic Phemomena.

Orig Pub : Eksperim. i teor. fiziki, 1956, 30, No 2, 421 - 422.

Abstract : Starting out with the kinetic equation with vector phase space magnetization density, an equation is derived for the variation of the density M (t) of the magnetization of the conduction electron of the metal in a magnetic field. Account is taken here of the collisions between electrons in thermal motion, accompanied by a change in the directions of the electron spins; the resultant equation therefore describes the spin-lattice spin relaxation processes. The author's results are in agreement with Dyson's work who determined by means of complicated calculations M(t) with allowance for the diffusion of the electrons of the metal.

Card : 1/1

SILIN, V. P.

56-2-26/47

AUTHOR: Silin, V. P.,

TITLE: (Note on) the Theory of a Degenerate Electron Liquid (K teorii vyrozhdennoy elektronnoy zhidkosti)

PERIODICAL: Zhurnal Eksperim. i Teoret. Fisiki., 1957, Vol. 33, Nr 2(8), pp. 495-500, (USSR)

ABSTRACT: The object of the paper under consideration is the expansion of Landau's theory on a degenerate electron liquid. Landau's theory permits a phenomenological consideration of the correlation of electrons. The modifications must be investigated, which are caused by the limited effective of the forces acting between the electrons. The theory by Landau of a fermi-liquid and the approximation by Hartree-Fock: At the outset those theories are compared in their application to the kinetic equation considered in a linear approximation. The corresponding states are differing only littlefrom the homogeneous equilibrium states. Landau's theory of the fermi-liquid takes no consideration of the effects, which are possibleif the effective range of the forces is of the same order of magnitude as the inhomogeneities of the liquid. For this reason this theory cannot be applied immediately to the Coulomb interaction. The energy as a functional of the distribution function in the case of Coulomb interaction of particles: Because of the considerable self consisting interaction of the particles the energy of a single particle is dependent on the state of the surrounding

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56-5-24/46

AUTHOR: Silin, V.P.

TITLE: Oscillations of a Fermi Liquid in a Magnetic Field (Kolebaniya Fermi-zhidkosti, nakhodyashcheysya v magnitnom pole)

PERIODICAL: Zhurnal Eksperim. i Teoret.Fiziki, 1957, Vol. 33, Nr 5, pp. 1227-1234 (USSR)

ABSTRACT: Kinetic equations for the case without a magnetic field were set up by Landau (ref.2). These equations are now extended to the assumption that the spin oscillations of a Fermi liquid take place in a magnetic field. Further, the spin oscillations for the spatial-homogeneous case are investigated and the frequencies of such oscillations are computed. In this case the frequencies are limit values of the spin wave frequencies if the wave lengths tend towards infinity. The presence of a constant magnetic field makes it possible that the spin waves are propagated in real, liquid He^3. There are 6 Slavic references.

ASSOCIATION: Physics Institute imeni P.N.Lebedev AN USSR (Fizicheskiy institut im.P.N.Lebedeva AN SSSR)

SUBMITTED: May 6, 1957

AVAILABLE: Library of Congress

Card 1/1

56-5-34/46

AUTHOR: Silin, V.P.

TITLE: On the Theory of Anomalous Skin Effect in Metals (K teorii anomal'nogo skin-effekta v metallakh)

PERIODICAL: Zhurnal Eksperim. i Teoret.Fiziki, 1957, Vol. 33, Nr 5, pp. 1282-1286 (USSR)

ABSTRACT: The attempt is made to explain the phenomena of the anomalous skin effect by means of the theory of Fermi liquids modified by Landau, and the author extends this theory to a degenerated "electron liquid". It is shown that what is known about the Fermi surfaces, which are obtained from measuring the surface impedance within the domain of the anomalous skin effect, does not depend on whether, in the case of electron conductivity, the electrons are regarded as a gas or as a degenerated liquid. It is shown that, when exploiting experimental data, the use of the isotropic metal model represents a good auxiliary for the purpose of easily computing its parameters:
v_0 (electron velocity on the Fermi surface)
p_0 (electron momentum) and
$A = p_0^2 \int d\Omega \cos\chi \, F(\cos\chi)$. There are 9 references, 5 of which are Slavic.

Card 1/2

SOV/56-34-3-.../...

AUTHOR: Silin, V. P.

TITLE: Optical Properties of Metals in the Infrared Range
(Ob opticheskikh svoystvakh metallov v infrakrasnoy oblasti)

PERIODICAL: Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, 1958,
Vol. 34, Nr 3, pp. 707 - 713 (USSR)

ABSTRACT: These optical properties can be described by Landau theory for the Fermi liquid. The present work shows that the results obtained by it essentially differ from the corresponding results from the usual electron theory of metals. First the author shortly reports on earlier works dealing with the same subject. Within the range of small frequencies where the static characteristics of metals can be neglected this theory based on the conception of electron liquid does not differ from the usual theory. The same applies also for a clearly pronounced anomalous skin effect. First an equation for the description of the electrons of the quasiparticles of the degenerated electron liquid - is given. The collision integral of the Fermi liquid coincides with the usual one. The equation just mentioned is then specialized for the infra-

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SOV/ 56-34-3-26/55

Optical Properties of Metals in the Infrared Range

red range and put down in zero-th approximation. From this can then easily be determined the zero-th approximation of the complex tensor of conductivity $\sigma_{\alpha\beta}$ ($j_\alpha = \sigma_{\alpha\beta} E_\beta$) as well as the corresponding tensor of the complex dielectricity constant. Also for the surface impedance of the metal a formula is put down. In zero-th approximation the density of the electric charge is equal to zero, and the continuity equation then has the form div $\vec{j} = 0$. The expression for the surface impedance obtained is purely imaginary. Then the author investigates the case where the collision integral and the term containing the constant magnetic field strength are essentially greater than those terms containing a derivative with respect to the coordinate. The resulting expression for the density of current is put down. Also the case where the skin effect is neither normal nor anomalous is of interest. This solution of the problem is, however, practically already contained in the results given. The perturbations leading to the correction of first approximation enter the corresponding equations in an additive way. An expression for the surface impedance in a general case is put down. The results obtained

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[illegible] Properties of Metals in the Infrared Range

are essentially simplified when the metal can be regarded as being isotropic. Some formulae found earlier are here specialized for this case. There are 10 references, 6 of which are Soviet.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Institute for Physics imeni P. N. Lebedev AS USSR)

SUBMITTED: October 1, 1957

SOV/ 56-34 -3-55/55

AUTHOR: Silin, V. P.

TITLE: On the Theory of Plasma Waves in a Degenerated Electron Liquid (K teorii plazmennykh voln v vyrozhdennoy elektronnoy zhidkosti)

PERIODICAL: Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, 1958, Vol. 34, Nr 3, pp. 781-782 (USSR)

ABSTRACT: According to the theory by Landau (reference 2) of the Fermi liquid the kinetic equation for the non-equilibrium additional part δn of the distribution function of the quasiparticles (electrons) of the degenerated electron liquid reads

$$\frac{\partial \delta n}{\partial t} + \vec{v} \frac{\partial}{\partial r} \left\{ \delta n - \delta \varepsilon \frac{\partial n_0}{\partial \varepsilon_0} \right\} + e\vec{E}\vec{v} \frac{\partial n_0}{\partial \varepsilon_0} = 0$$

n_0 denoting the distribution function holding for equilibrium and ε_0 the energy of the electron in theequilibrium state. The author investigates the solutions of the above mentioned equation in the form $\delta n_k e(i\vec{k}\vec{r} - i\omega t)$ and is interested in the case of long waves, which makes possible an expansion with respect

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to the powers of $\vec{k}$. On the condition that the Fermi-plane is a sphere the following dispersion relation is obtained for the dependence of the frequency ω of the plasma waves on the vector within the range of long waves:

$$\omega^2 = \omega_0^2 + v_0 V_0((3/5) + A_0 + (4/25)A_2)k^2.$$

v_0 and p_0 denoting the velocity and the momentum of the electron on the Fermi liquid; A_0 or A_2 respectively denote the coefficients of the development according to the Legendre-polynomials. $A_n = 0$ holds for an ideal Fermi gas of the electrons, and the last mentioned formula transforms into the corresponding formula of the previous work by Gol'dman (Ref 1). The author then estimates the coefficients A_n for the case that the function Φ is determined by the amplitude of the scattering to the front. This amplitude is here computed in the Born approximation for a screening Coulomb potential. When the anisotropy of the metal is taken into account in the approximation $\omega_0^2/v_0^2 \gg k^2 \gg \omega_0^2/c^2$ (where c denotes light velocity) also the term of longitudinal waves can be used. Then an

On the Theory of Plasma Waves in a Degenerated Electron Liquid SOV/56-34-3-55/55

equation is given for the determination of the frequency of plasma vibrations. All which has been said here can refer to real metals onyl when the enery of the plasma vibration is small compared to the distance from the conduction zone to the next filled zone. The dependence of the frequency of the plasma waves on the direction of the vector $\vec{k}$ can lead to a widening of the line of discreet losses of electrons on the passage through non-cubic metals. There are 4 references, 4 of which are Soviet.

ASSOCIATION: Fizicheskiy institut im. P.N. Lebedeva Akademii nauk SSSR (Physical Institute imeni P.N. Lebedev AS USSR)

SUBMITTED: January 2, 1958

USCOMM-DC-60,620

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SOV/56-35-4-2?/?

24(3)

AUTHOR: Silin, V. P.

TITLE: On the Theory of the Optical Properties of Conductors for the Case of Oblique Incidence of Radiation (K teorii opticheskikh svoystv provodnikov dlya sluchaya naklonnogo padeniya izlucheniya)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 4, pp 1001 - 1004 (USSR)

ABSTRACT: One of the problems of macroscopic electrodynamics is the investigation of the optical properties of conductors irrespective of the anomalous skin effect. The anomalous skin effect must be taken into account only if the penetration depth of the electromagnetic field is comparable to or smaller than the free path length of the electrons; investigation of optical properties within range of the anomalous skin effect is carried out according to a microscopical theory (Refs 1-7). In the present paper, however, the case is investigated in which the average free path length of the electrons is

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On the Theory of the Optical Properties of Conductors SOV/[illegible]-[illegible]-4-[illegible]/[illegible]
for the Case of Oblique Incidence of Radiation

small compared to the characteristic distance of the electromagnetic field, or a modification of the anomalous skin effect and which means neglect of the macroscopic theory. The application of the macroscopic to the ordinary optics of conductors is a consequence of the difference with respect to the surface current, which results from the scattering of the electrons on the surface of the sample. It is assumed that radiation falls at an arbitrary angle on the surface of a massive conductor; for an isotropic medium it then holds that $\vec{D} = \varepsilon(\omega)\vec{E}$. $v/\omega \ll \delta \sim c/\sqrt{|\varepsilon(\omega)|}\omega$ or $v/c \ll 1/\sqrt{|\varepsilon(\omega)|}$, and $\vec{I} = \gamma(\omega)\{\vec{E} - \vec{n}.(\vec{n}\vec{E})\}$, where $\gamma(\omega)$ denotes the surface conductivity and $\vec{n}$ the normal vector on the surface. With these material equations and the Maxwell equations (Maksvell) equations for the complex reflection- and the complex refraction indices are derived and the case $\varepsilon(\omega) \gg 1$ is investigated. It is shown that the effective complex refraction indices depend on the angle of

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On the Theory of the Optical Properties of Conductors for the Case of Oblique Incidence of Radiation SOV/56-35-4-2/52

incidence θ (compare formulae 5 and 7 for $n^2(\theta)$ and $n_r^2(\theta)$) and differ among one another as to the different polarization of the **incident** radiation. This difference is, with respect to its order of magnitude, equal to the ratio between electron velocity and the velocity of life. For $\varepsilon(\omega) \gg 1$ the following is obtained for the effective dielectricity constant:

$\varepsilon_{eff}(\omega) = \varepsilon(\omega) + (8\pi\gamma/c)\sqrt{\varepsilon(\omega)} + (4\pi\gamma:c)^2$. There are 9 references, 6 of which are Soviet.

ASSOCIATION: Fizicheskiy institut im. P.N.Lebedeva Akademii nauk SSSR (Physics Institute imeni P.N.Lebedev of the Academy of Sciences USSR)

SUBMITTED: May 21, 1958

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SOV/56-35-5-27/56

24(5)

AUTHOR: Silin, V. P.

TITLE: Oscillations of a Degenerated Electron Fluid (Kolebaniya vyrozhdennoy elektronnoy zhidkosti)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 5, pp 1243-1250 (USSR)

ABSTRACT: The author of the present paper investigates the oscillations of an electron fluid on the basis of Landau's theory of the Fermi fluid (Ref 1). An investigation of these oscillations by means of the general theory of the degenerated electron fluid permits consideration of the longitudinal plasma waves as well as of the transversal electromagnetic waves (Refs 2-4). Here the interaction between electrons which is caused by the electromagnetic field is taken into consideration. This consideration is, however, of use only if interaction between electrons is small compared to their kinetic energy. If this is not the case, the exchange correlation of electrons changes the kinetic equation (Ref 5). The theory developed by Landau has already been discussed (Ref 6). The author bases his investigations of electron fluid oscillations upon an equation of motion (according to

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reference 6) for quasiparticles as well as on the Maxwell equations. Without considering spin-orbit interaction, plasma waves, electromagnetic waves, zero sound and spin waves are investigated. A major part of references mentioned in this paper are earlier papers by the same author. There are 11 references, 10 of which are Soviet.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Physics Institute imeni P. N. Lebedev of the Academy of Sciences, USSR)

SUBMITTED: May 31, 1958

SILIN, V.P.

Determination of the effective mass of carriers and optical constants of semiconductors. Fiz.tver.tela 1 no.5:705-708 My '59. (MIRA 12:4)

1. Fizicheskiy institut im. P.N. Lebedeva, Moskva. (Semiconductors)

05482

SOV/141-2-2-7/22

AUTHOR: Silin, V.P.

TITLE: Electromagnetic Fluctuations in the Media Having a Spatial Dispersion

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Radiofizika, 1959, Vol 2, Nr 2, pp 198 - 202 (USSR)

ABSTRACT: The theory of electromagnetic fluctuations (S.M. Rytov et al. - Refs 1-4) shows that if there exists a local functional dependence between the induction and the intensity of the electromagnetic field:

$$D_i(\underline{r}) = \epsilon_{ij}(\omega)E_j(\underline{r}) \ , \quad B_i(\underline{r}) = \mu_{ij}(\omega)H_j(\underline{r}) \qquad (1)$$

the correlation of the random inductions is also of the local type. Some corollaries of this theory can be derived from the following formula (Ref 4), which determines the fluctuations of the electromagnetic field in an infinite isotropic medium:

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Electromagnetic Fluctuations in the Media Having a Spatial Dispersion

$$(\underline{E}(\underline{r})\underline{E}(\underline{r}'))_{\omega} = 2\hbar\,\mathrm{cth}\frac{\hbar\omega}{2\varkappa T}\left\{\frac{\varepsilon''(\omega)}{|\varepsilon(\omega)|^{2}}\delta(\underline{R}) + \frac{i\omega^{2}}{Rc^{2}}\left[e^{-\frac{\omega}{c}\sqrt{-\varepsilon}R} - e^{-\frac{\omega}{c}\sqrt{-\varepsilon^{*}}R}\right]\right\} \qquad (2).$$

The left-hand side of Eq (2) is related to the average value of the product of the field components by means of Eq (3). In the above equations, the notation is as follows:

$\underline{R} = \underline{r} - \underline{r}'$, $\varepsilon''(\omega)$ is the imaginary component of the permittivity ($\varepsilon = \varepsilon' + i\varepsilon''$);

ω is the frequency of the electromagnetic field (which is a sinusoidal function of time);

T is the temperature,

$\varkappa$ is the Boltzman constant.

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Electromagnetic Fluctuations in the Media Having a Spatial Dispersion

The peculiarity of Eq (2) is the presence of the δ-function in front of the term which is proportional to the imaginary component of the permittivity; this leads to infinitely high fluctuations of the electric field in dissipative media. This singularity corresponds to the longitudinal field fluctuations. The singularity can be eliminated if the equations are constructed which permit the existence of longitudinal electromagnetic waves so that to each frequency ω corresponds a wave having a definite wave vector k. The spatial dispersion of the electric field can be taken into account by employing Eq (4) (V.L. Ginzburg - Ref 5). The induction and the intensity of the electromagnetic field are related by means of the integrals (V.D. Shafranov - Ref 7):

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$$D_i(\underline{r}) = \int d\underline{r}' Q^D_{ij} (\underline{r}, \underline{r}'; \omega) E_j(\underline{r}') ; \tag{5}$$

$$B_i(\underline{r}) = \int d\underline{r}' Q^B_{ij} (\underline{r}, \underline{r}'; \omega) H_j(\underline{r}')$$

where the kernels Q^D and Q^B may be dependent on the form of the media considered. In order to investigate the fluctuations, it is necessary to add to the right-hand side terms of Eqs (5) two random functions K and L which denote the inductions of the electric and the magnetic field, respectively. The correlation of these inductions is expressed by Eq (6) (Ref 4). The Maxwell equations, when written in terms of Fourier components, are in the form of Eqs (7); similarly, Eq (6) can be written as Eqs (8). On the basis of Eqs (7), the fields are given by Eqs (9). From these and Eqs (8), it is possible to derive Eqs (10) and (11). By employing an

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Electromagnetic Fluctuations in the Media Having a Spatial Dispersion

inverse Fourier transformation, the average value of the product of the electric field components is given by:

$$\overline{E_i(\underline{r},\omega)E_j(\underline{r}',\omega')} = (E_i(\underline{r})E_j(\underline{r}'))_\omega \delta(\omega + \omega') =$$

$$= - 2\hbar\delta(\omega + \omega')\mathrm{cth}\frac{\hbar\omega}{2\varkappa T}\Phi_{ij}(\underline{R}, \omega) \qquad (12)$$

where Φ_{ij} is expressed by the next formula on p 201. The correlation function for the longitudinal fields is therefore given by Eq (13). Now, if the equation which permits the existence of longitudinal waves is in the form of Eq (14), where α and β are real, Eq (2) can be written as Eq (15). The first component in square brackets in this equation corresponds to the longitudinal field, while the second component represents the transverse

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Electromagnetic Fluctuations in the Media Having a Spatial Dispersion

field. It is seen that Eq (15) does not contain the singularity in the form of $\delta(R)$. Further, when the complex permittivity tends to zero, the fluctuations of the longitudinal field do not tend to an infinitely large amplitude but, on the contrary, tend to decrease. The author makes acknowledgment to V.L. Ginzburg for his interest in this work. There are 10 Soviet references.

ASSOCIATION: Fizicheskiy institut im. P.N. Lebedeva AN SSSR (Physics Institute im. P.N. Lebedev of the Ac.Sc., USSR)

SUBMITTED: January 2, 1959

Card 6/6

SOV/126-7-3-2/44

AUTHOR: Silin, V. P.

TITLE: On the Theory of Conductivity

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 7, Nr 3, pp 331-334 (USSR)

ABSTRACT: The usual theory of conductivity of metals (Ref 1) is based on the assumption that the conduction electrons may be looked upon as a gas of non-interacting particles. In reality the interaction between the electrons is not small (Ref 2) and it is therefore natural to suppose that many of the results of the usual theory of conductivity might be incorrect. This means that it is desirable to set up a theory of conductivity in which the conduction electrons are looked upon as a degenerate electron fluid. The problem may be solved using the Fermi fluid theory put forward by Landau in Ref 3 and treated by the present author in Ref 4. It is shown in the present paper that the theory of conductivity based on the electron fluid idea leads to the same results as the usual theory. The phenomena considered are: electrical conductivity, thermal conductivity, and thermoelectric galvanomagnetic and thermomagnetic effects.

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On the Theory of Conductivity SOV/126-7-3-2/44

A similar result is obtained in the case of liquid He^3. There are 7 references, 5 of which are Soviet, 1 English and 1 a translation from English.

ASSOCIATION: Fizicheskiy institut imeni P. N. Lebedeva AN SSSR (Physical Institute imeni P. N. Lebedev, Ac.Sc., USSR)

SUBMITTED: November 20, 1957

Card 2/2

SOV/51-7-4-18/32

AUTHORS: Wan Ji-fu, Silin, V.P. and Fetisov, Ye.P.

TITLE: On the Optical Properties of Metal Films in the Region of Anomalous Skin Effect.

PERIODICAL: Optika i spektroskopiya, 1959, Vol 7, Nr 4, pp 547-551 (USSR)

ABSTRACT: Thin films can be used to determine optical constants of conductors. Theory of the optical properties of films has usually neglected anomalous skin effect, which is very important in many metals (Refs 2-4). The authors fill this gap by considering optical properties of metal (conducting) films in the case when the surface losses due to the diffuse scattering of electrons at the surface cannot be neglected. Formulae are given for the phase-shifts of reflected (α) and transmitted (β) waves for the reflection (R) and transmission (T) coefficients and the absorption coefficient A = 1 - R + T. They are given both for s-polarization (Eqs 7-11) and p-polarization (Eqs 12-16). The formulae simplify considerably in the limiting cases of very

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On the Optical Properties of Metal Films in the Region of Anomalous Skin Effect

thin films and massive conductors. Further simplification occurs when the real part of permittivity is considerably larger than unity. The paper is entirely theoretical. There are 6 references, 3 of which are Soviet, 1 English, 1 Dutch and 1 mixed (Soviet, English and German).

SUBMITTED: February 18, 1959

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SOV/56-36-5-21/76

24(4)

AUTHOR: Silin, V. P.

TITLE: On the Problem of Optical Constants of Conductors (K voprosu ob opticheskikh postoyannykh provodnikov)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 5, pp 1443-1450 (USSR)

ABSTRACT: In an earlier paper (Ref 1) the author investigated a theory of the optical properties for the case of an inclined incidence of radiation upon the surface of a massive conductive body. The anomalous skin effect is taken into account by the introduction of a boundary condition on the surface of the conductor. The surface resistance thus taken into account leads to an additional loss which corresponds to the diffusion scattering of the conductivity electrons in the metal surface. In the present paper the problem of determining the complete set of optical constants and the fluctuations of the electromagnetic field and the electrodynamical relations in consideration of a boundary impedance $z = \gamma^{-1}$ is discussed. The impedance is connected with the surface current density $\vec{i}$ and the

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tangential components of the electric field according to $\vec{i} = \gamma(\omega)\left\{\vec{E}-\vec{n}(\vec{n}\vec{E})\right\}$. $\gamma(\omega)$ denotes the complex surface conductivity and $\vec{n}$ is the external vertical on the surface of the conductive body. For anisotropic conductors and cubic crystals it holds $i_\alpha = \gamma_{\alpha\beta} E_\beta$, where $\gamma_{\alpha\beta}$ is the two-dimensional surface tensor. In the following, conditions are discussed first without considering the anomalous skin effect of $\vec{D} = \varepsilon\vec{E}$ and the complex dielectric constant $\varepsilon(\omega) = (n-i\varkappa)^2 = \varepsilon_1 + i\varepsilon_2$, and then in consideration of the anomalous skin effect if $\vec{D} = \varepsilon\vec{E} + a\Delta\vec{E} + b \operatorname{grad} \operatorname{div} \vec{E}$.

It is shown among other things that for an isotropic conductor two real quantities that correspond to complex boundary impedance, must be taken into account besides the refraction index n and the absorption constants $\varkappa$. The real part of the boundary impedance determines the surface losses, and the imaginary part of ε determines the volume losses. The relations are discussed which exist between the real- and the imaginary parts of complex surface conductivity.

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For the field components of an isotropic metal in the semi-space a correlation formula is derived and discussed. There are 7 references, 6 of which are Soviet.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Physics Institute imeni P. N. Lebedev of the Academy of Sciences, USSR)

SUBMITTED: November 5, 1958

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21 (8) SOV/56-37-1-40/64

AUTHOR: Silin, V. P.

TITLE: On Collective Losses of Fast Electrons in the Passage Through Matter (O kollektivnykh poteryakh bystrykh elektronov pri prokhozhdenii cherez veshchestvo)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 1(7), pp 273 - 282 (USSR)

ABSTRACT: The present paper deals with the problem of losses of fast electrons which pass through thin films from the point of view of the theory developed by I. Ye. Tamm, I. M. Frank, and E. Fermi (Ref 1), taking spatial dispersion of the dielectric constant into consideration. At first, a short report is given on the general stage of the problem. Spatial dispersion leads to the circumstance that the dielectric constant is a tensor even in an isotropic medium, and has the form

$$\varepsilon_{ij}(\omega,\vec{k}) = \varepsilon^{tr}(\omega,k)\left\{\delta_{ij} - \frac{k_i k_j}{k^2}\right\} + \frac{k_i k_j}{k^2}\,\varepsilon^{l}(\omega,k),$$

ε^{tr} and ε^{l} denoting the transverse and the longitudinal dielectric constant. By use of the afore-mentioned formula, the author finds an expression for the energy loss of a fast charged particle per

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unit of length in the passage through matter:

$$W = \frac{ie^2Z^2}{\pi v^2}\int_{-\infty}^{+\infty}\omega d\omega\int_0^{\infty} qdq\,\frac{1}{q^2+\omega^2/v^2}\left\{\frac{1}{\varepsilon^l(\omega,\sqrt{q^2+\omega^2/v^2})} - \frac{v^2}{c^2}\,\frac{q^2}{q^2+\omega^2\left[v^{-2}-c^{-2}\varepsilon^{tr}(\omega,\sqrt{q^2+\omega^2/v^2})\right]}\right\}.$$

Ze denotes the charge, and v the velocity of the fast particle. The first summand in the curly bracket depends on the emission of longitudinal waves, the second summand by the transverse Cherenkov-radiation. As ordinary collective losses of fast electrons are just connected with the emission of longitudinal waves, the author concentrates his attention upon the first summand in the above formula. An expression for the probability of scattering of a fast particle per unit-length of path into the angle $d\theta$ with emission of a longitudinal quantum (Plasmon) in the frequency interval $d\omega$ is then written down. The experimentally measurable quantity is therefore $\mathrm{Im}\left\{1/\varepsilon^l(\omega,k)\right\}$, and this very quantity

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must be determined by the theory of collective losses by using one or the other model representations of the electrons of the medium. The author then finds the corresponding expressions for ε^1 for the case of an electron gas of high density and for an electron liquid. Further, certain particularities of the losses of fast particles (which are connected with a possible excitation of the zero sound) are discussed. For the spectrum of plasma vibrations, the expression

$$\omega^2 = \omega_0^2 + \frac{3p_0^2k^2}{5m^2} - \omega_0^2 \frac{3}{20}\left(\frac{\hbar k}{p_0}\right)^2$$

is obtained. The longitudinal dielectric constant of a degenerate electron liquid is then calculated according to L. D. Landau's theory (Ref 3) of the Fermi liquid. In the next part, an expression for the probability of scattering of a fast electron per unit-length of path with emission of a longitudinal quantum is found, and some conclusions for that range where the spatial dispersion is no longer weak are also discussed. The next part deals with another possibility which leads to a dependence of the amount of dis-

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crete losses on the scattering angle, and is not connected with spatial dispersion. Such a possibility results in the case of optically anisotropic media. For relativistic electrons, the role of transverse quanta, and particularly the Cherenkov-radiation, must be considered in the investigation of losses. The author thanks V. L. Ginzburg and L. D. Landau for the kind discussion of some problems. There are 18 references, 13 of which are Soviet.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Institute of Physics imeni P. N. Lebedev of the Academy of Sciences, USSR)

SUBMITTED: February 23, 1959

SOV/56-37-1-23/64

24(8).

AUTHORS: Zharkov, V. N., Silin, V. P.

TITLE: The Theory of Weak Solutions of He^4 in Liquid He^3 (Teoriya slabykh rastvorov He^4 v zhidkom He^3)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 1(7), pp 143-153 (USSR)

ABSTRACT: The present paper is concerned with the thermodynamics and the kinetic phenomena in weak solutions of He^4 in liquid He^3. In the case of such a solution, 2 kinetic coefficients are to be considered in addition to the viscosity coefficient η and the heat-conduction coefficient $\varkappa$, i.e. the diffusion coefficient D and the coefficient of thermodiffusion Dk_T, k_T denoting the thermodiffusion ratio. These coefficients are determined by the equations $\vec{I} = -\varrho D(\nabla c + \frac{k_T}{T}\nabla T)$ at $\vec{g} = \vec{g}_{imp} + \vec{g}_{Fermi} = 0$, $\vec{Q} = -\varkappa \nabla T$ at $\vec{I} = 0$. $\vec{I}$ denotes the current of impurities, Q the heat flow, $\vec{g}$ the total current of the momentum in the solution; the latter is composed of the momentum transferred by the impurity excitations $\vec{g}_{imp}$, and of the momentum $\vec{g}_F$ transferred by the Fermi

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excitations. Instead of the usual deviation of the distribution function of the Fermi excitations from the equilibrium value δn_{Φ}, a certain effective expression $\overline{\delta n_{\Phi}} = \delta n_{\Phi} - \frac{\partial n}{\partial \varepsilon}\int \delta n_{\Phi} f(\vec{p},\vec{p}\,')d\tau'$ enters the collision integrals caused by the scattering of the Fermi excitations. But the same expression appears, instead of the usual δn_{Φ}, in the formulas for the various currents determined by Fermi excitations. This is why the form of δn_{Φ} is not observable in the calculations. The first part of the present paper deals with the thermodynamics of weak solutions of He^3 in liquid He^4. The authors investigate the conditions under which the dissolved He^4 atoms can be described by Boltzmann's statistics. The deviations from classical statistics occur at those temperatures at which only the interaction of the impurity excitations between each other, or the quantumlike degeneration of the impurity gas, are essential. The spin of the atoms is equal to zero, and the temperature T_o of the degeneration of the impurity gas is therefore equal to $T_o = \hbar^2 n_o^{2/3} c^{-2/3}/kM)(3^{2/3}\pi/2)$. $n_o = \varrho/m^3$ denotes the number of atoms

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of pure He^3 in 1 cm^3, m_3 the mass of the He^3 atom, $\bar{c}$ the concentration of He^3. The authors then compare T_o with those temperatures at which the interaction of the impurities between each other plays a certain role. The second part deals with the kinetic equation. This equation determines the distribution function of the elementary excitations in the solution of He^4 in liquid He^3, and has the form: $\mu_\Phi = \mu_o - kT\bar{c}$. The authors derive the kinetic equation for the Fermi excitations and also for the impurities, the collision integrals in the standard form as well as the effective cross sections for the scattering of the impurities on the Fermi excitations and impurities. The third part deals with the diffusion of the impurities. As this problem can hardly be solved accurately, the two limiting cases of high (range of validity of the Pomeranchuk law) and low temperatures are investigated; the results in the intermediate range can then be determined by interpolation. The corresponding diffusion coefficients are explicitly written down. The thermodiffusion ratio is calculated in a similar manner as the diffusion coefficient. The thermodiffusion coefficient is

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small as compared with the diffusion coefficient. The viscosity and the thermal conductivity are calculated in the last two parts. The authors thank B. I. Davydov for a useful discussion. There are 14 Soviet references.

ASSOCIATION: Institut fiziki Zemli Akademii nauk SSSR (Institute for the Physics of the Earth of the Academy of Sciences, USSR)

SUBMITTED: January 23, 1959

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RUKHADZE, A.A.; SILIN, V.P.

Magnetic susceptibility of relativistic electron gas. Zhur.eksp.i teor.fiz. 38 no.2:645-646 F '60. (MIRA 14:5)

1. Fizicheskiy institut im. P.N.Lebedeva Akademii nauk SSSR.
(Electron gas)

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24.1800

AUTHOR: Silin, V. P.

TITLE: The Theory of Ultrasonic Absorption in Metals

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 3, pp. 977-983

TEXT: The article under review describes a theoretical investigation of sound absorption in the low-temperature range where absorption is caused by electrons. The frequencies under consideration were so high that the condition $\lambda \ll l$ (λ - sound wave length, l - mean free path of electrons) is satisfied. In the limiting case l may be considered infinitely small. The processes taking place under these conditions are similar to those developing in a degenerate electron gas. The damping of sound waves may be studied in a similar manner as that of plasma waves (detected by Landau). In a previous paper, the author found that in this case absorption is a linear function of frequency (longitudinal sound). Absorption for longitudinal and transverse sound has been investigated by Pippard. All these previous investigations have the disadvantage that 1) the Fermi

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...electrons in

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the metal are not regarded as a gas, but as a fluid; Landau's theory of the Fermi fluid). The author finally thanks V. L. Ginzburg for his discussions. There are 11 references, 8 of which are Soviet.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Institute of Physics imeni P. N. Lebedev of the Academy of Sciences, USSR)

SUBMITTED: October 24, 1959

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26.2311
24.2120

AUTHOR: Silin, V. P.

TITLE: The Electromagnetic Properties of a Relativistic Plasma

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 5, pp. 1577-1583

TEXT: The theory of a relativistic electron plasma has already been studied by several authors (Refs. 1-7). The present paper deals with those electromagnetic properties of an electron plasma, which may be characterized by a complex dielectric constant, taking spatial dispersion into account. Dissipation due to particle collisions is not taken into account. First, the author considers a plasma, in which induction and electric field strength are non-locally coupled not only with respect to time but also to space. General relations are given for $\vec{D}(\vec{r},t)$ and $\varepsilon_{ij}(\omega,\vec{k})$. Most of the electromagnetic properties are, however, to be treated with the expression holding for isotropic systems:

$$\varepsilon_{ij}(\omega,\vec{k}) = (\delta_{ij} - k_i k_j/k^2)\varepsilon^{tr}(\omega,k) + (k_i k_j/k^2)\varepsilon^{l}(\omega,k).$$

The conditions for

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transverse and longitudinal oscillations are given (ε^{tr}, ε^{l}), and the screening radius of interaction is defined:
$\lim_{k=0} \lim_{\omega/k=0} k^2(\varepsilon^l - 1) = r_{scr}^{-2}$. Another characteristic quantity is the skin depth. For $\omega/k \to 0$ it characterizes the distance at which the transverse field changes: $\varepsilon^{tr} = (4\pi i/\omega)\sigma^{tr}(k)$; $\sigma^{tr} = C/k$. C is a constant that depends on the actual properties of the plasma. The penetration depth of the transverse field is equal to $\delta = (2c^2/\pi C\omega)^{1/3}$. By use of these general relations, the author determines the tensor of the dielectric constant for an electron-ion plasma in Vlasov's self-consistent field approximation. The electron and ion distribution functions are given, and an expression (8) is obtained for $\varepsilon_{ij}(\omega,\vec{k})$ from the linearized equations of motion (the solution of the equation of electron motion is given by (6), that for the ions is analogous). With $\omega = \vec{k}\vec{v}$ one obtains the relations given by (9) for $\varepsilon(\omega)$, r_{scr}^{-2} and C. In the following, the author studies an ultrarelativistic electron plasma for which he calculates the contributions of the ultrarelativistic electrons to the dielectric constant. The contributions of the

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The Electromagnetic Properties of a Relativistic Plasma

characteristics defined by formula (9) are given by (14). In the last part of the present paper, the author investigates the propagation of electromagnetic waves in a relativistic plasma. Expressions are given for the frequencies of the longitudinal and transverse waves propagating in an isotropic plasma, and various relations are derived for the velocity of sound (special cases) and the decrement of damping. L. D. Landau is mentioned. There are 13 references: 10 Soviet, 2 British, and 1 Danish.

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24.2120

AUTHOR: Silin, V. P.

TITLE: Kinetic Equation for Rapidly Changing Processes

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 6, pp. 1771-1777

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TEXT: The object of the present work was to obtain a kinetic equation suitable for describing processes whose characteristic times are smaller than or comparable to the collision times. The equation is obtained on the basis of the model of a gas whose particles interact with one another weakly but whose state is subjected to rapid changes (e.g., a plasma). The analogous problem for slower processes was considered by L. D. Landau earlier. The equation is obtained by the method of perturbation theory. The author follows the method of N. N. Bogolyubov (Ref. 2), that is, to obtain the equation of motion for the distribution function $f(\vec{p},\vec{r})$, the correlation function $g(\vec{r},\vec{r},\vec{p}',\vec{r}')$ is first derived. It is first shown for a gas of charged particles in the absence of a magnetic field that for

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frequencies $\omega \gg \omega_o$ (ω_o Langmuir frequency), the maximum impact parameter in the Coulomb logarithm is not the Debye screening range but the distance traveled by the particles during the electric field period. The kinetic equation (11) is obtained for a charged particle gas placed in a constant homogeneous magnetic field and a homogeneous electric field varying in time. The correlation factor is given by (12). In the case of a homogeneous distribution in space, the right side of equation (11) has the form (12) where (14) holds. For Coulomb interaction $\nu_{\alpha\alpha'}(k) = 4\pi e_\alpha e_{\alpha'} k^{-2}$, so that (15) and (16) are obtained. In the latter case, the integration with respect to τ must be performed from τ_{max} to τ_{min};

$\tau_{min} \sim e^2 \sqrt{m}\,(\varkappa T)^{-3/2} \sim 10^{-8} T^{-3/2}$, $\tau_{max} \sim \sqrt{m/4\pi e^2 n}$, $\omega_o^{-1} \sim 10^{5} n_o^{-1/2}$;

T - temperature, n_o - electron density per unit volume, Ω - Larmor frequency. The equations relate to α-th particles. The effective frequency of collisions between electrons and ions which determines the

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dissipative part of the tensor of the complex dielectric constant of a plasma located in a strong constant magnetic field is computed for the same case of high frequencies. If $\Omega \gg \omega_0$, the maximum impact parameter in the Coulomb logarithm depends, in a resonant manner, on the frequency of the variable field. V. L. Ginzburg is thanked for discussions. There are 5 references: .. Soviet and 1 British.

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Institute of Physics imeni P. N. Lebedev of the Academy of Sciences USSR)

SUBMITTED: December 24, 1959

$$\frac{\partial f_a}{\partial t} + \mathbf{v}\frac{\partial f_a}{\partial \mathbf{r}} + e_a\left(\mathbf{E} + \frac{1}{c}[\mathbf{vH}]\right)\frac{\partial f_a}{\partial \mathbf{p}} - \frac{\partial f_a}{\partial \mathbf{p}}\frac{\partial}{\partial \mathbf{r}}\int d\mathbf{p}'\,d\mathbf{r}'\sum_{a'} n_{a'}U_{aa'}(|\mathbf{r}-\mathbf{r}'|)\,f_{a'}(\mathbf{p}',\mathbf{r}') = = J_a \equiv \int d\mathbf{r}'\,d\mathbf{p}'\sum_{a'} n_{a'}\frac{\partial U_{aa'}(|\mathbf{r}-\mathbf{r}'|)}{\partial \mathbf{r}}\frac{\partial}{\partial \mathbf{p}}g_{aa'}(\mathbf{p},\mathbf{r},\mathbf{p}',\mathbf{r}',t), \qquad (11)$$

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$$
\begin{aligned}
g_{\alpha\alpha'}(\mathbf{p}, \mathbf{r}, \mathbf{p}', \mathbf{r}', t) = \int_{-\infty}^{0} d\tau \left\{ \frac{\partial}{\partial \mathbf{r}} U_{\alpha\alpha'}(|\mathbf{r} - \mathbf{r}' + \mathbf{a}(\tau, \mathbf{v}, \mathbf{v}', \alpha, \alpha', t)|) \right\} \times \\
\times \left\{ \frac{\mathbf{H}}{H^2} \left(\mathbf{H}, \frac{\partial}{\partial \mathbf{p}} - \frac{\partial}{\partial \mathbf{p}'} \right) + \frac{1}{H^2} \left[\mathbf{H} \left(\cos \Omega_\alpha \tau \frac{\partial}{\partial \mathbf{p}} - \cos \Omega_{\alpha'} \tau \frac{\partial}{\partial \mathbf{p}'}, \mathbf{H} \right) \right] - \right. \\
- \frac{1}{H} \left[\mathbf{H}, \sin \Omega_\alpha \tau \frac{\partial}{\partial \mathbf{p}} - \sin \Omega_{\alpha'} \tau \frac{\partial}{\partial \mathbf{p}'} \right] + \frac{1}{H} \left[\mathbf{H}, \frac{1 - \cos \Omega_\alpha \tau}{m_\alpha \Omega_\alpha} \frac{\partial}{\partial \mathbf{r}} - \right. \\
\left. - \frac{1 - \cos \Omega_{\alpha'} \tau}{m_{\alpha'} \Omega_{\alpha'}} \frac{\partial}{\partial \mathbf{r}'} \right] - \frac{1}{H^2} \left[\mathbf{H} \left[\frac{\sin \Omega_\alpha \tau}{m_\alpha \Omega_\alpha} \frac{\partial}{\partial \mathbf{r}} - \frac{\sin \Omega_{\alpha'} \tau}{m_{\alpha'} \Omega_{\alpha'}} \frac{\partial}{\partial \mathbf{r}'}, \mathbf{H} \right] \right] - \\
\left. - \tau \frac{\mathbf{H}}{H} \left(\mathbf{H}, \frac{1}{m_\alpha} \frac{\partial}{\partial r} - \frac{1}{m_{\alpha'}} \frac{\partial}{\partial \mathbf{r}'} \right) \right\} f_{\alpha'}(\mathbf{P}', \mathbf{R}', t + \tau) f_\alpha(\mathbf{P}, \mathbf{R}, t + \tau), \qquad (12)
\end{aligned}
$$

где $(\Omega_\alpha = e_\alpha H / m_\alpha c)$

$$
\begin{aligned}
\mathbf{P} = \frac{\mathbf{H}}{H}(\mathbf{pH}) + \frac{[[\mathbf{H}\,\mathbf{pH}]]}{H^2} \cos \Omega_\alpha \tau + \frac{[\mathbf{pH}]}{H} \sin \Omega_\alpha \tau + e_\alpha \int_t^{t+\tau} dt' \left\{ \frac{\mathbf{H}}{H} (\mathbf{HE}(t')) + \right. \\
\left. + \frac{[\mathbf{H}[\mathbf{E}(t')\mathbf{H}]]}{H^2} \cos \Omega_\alpha (\tau + t - t') + \frac{[\mathbf{E}(t')\mathbf{H}]}{H} \sin \Omega_\alpha (\tau + t - t') \right\},
\end{aligned}
$$

$$
\mathbf{R} = \mathbf{r} + \frac{1}{m_\alpha} \int_t^{t+\tau} dt' \mathbf{P}(t'), \qquad \mathbf{a} = \int_t^{t+\tau} dt' \left[\frac{\mathbf{P}(t')}{m_\alpha} - \frac{\mathbf{P}'(t')}{m_{\alpha'}} \right].
$$

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